USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title:NJ PINELANDS NATIVE FISH BIOLOGY: PARASITES AS BIOLOGICAL TAGS

Principal Investigators:

Introduced plants, mammals, birds, reptiles, insects and fish are common, and are often associated with human habitation (Forman, 1998). The Pinelands is home to 14 native fish species of which 6 are restricted native (i.e. within New Jersey their occurrence is restricted to the Pinelands) (Hastings, 1984). The remaining native species are found in waters in other regions of the state. It had been suggested that invasive species could displace some native species through biotic interactions (Smith, 1953). However, changes in the environment may also play a large part, and some situations in which exotic species had apparently displaced native species are now directly linked to the degradation of native species habitat (Graham, 1993).

An increase in urban and agricultural landscapes near forest lands threatens the preservation of Pinelands biodiversity by reducing stream acidity and increasing dissolved solid concentrations, allowing for the invasion of exotic species (Zampella & Laidig, 1997; Zampella & Bunnell, 1998). The use of bioindicator species to monitor changes within particular habitats is a concept that has long appealed to conservation biologists (McGeoch and Chown, 1998). Good indicators must be sensitive to environmental alteration so that changes in their numbers can be used as a warning of deteriorating conditions before the majority of less sensitive organisms are seriously affected. Parasites may rank among the most sensitive of bioindicators because parasite infections of fish reflect the health of the entire aquatic community (MacKenzie *et al*., 1995; Marcogliese and Price, 1997).

Fish parasites have complex life cycles, e.g., a typical parasite life cycle may include the fish definitive host, and one or more intermediate invertebrate hosts; for the parasite to survive, all hosts must co-occur in a stable community structure (Marcogliese and Cone, 1997). Most parasites are specific to a host species or to a group of closely related hosts (Marcogliese and Price, 1997). How specific a parasite is to its host(s) can depend on the type of parasite and/or on the stage in its life cycle. Trematodes, for example, must complete their development in at least 2 hosts, and the first intermediate host must usually be a mollusc (Roberts and Janovy Jr., 2000). Each host is integral in the completion of the parasite's life cycle, and if it infects the wrong host, it often dies or can cause serious problems for that host. For these reasons, parasites have been used for almost a century as biological indicators, tags, or markers to provide information on various aspects of host biology including fish stock separation, fish recruitment migrations, fish diet and feeding behavior, and host phylogenetics and systematics (Williams *et al*., 1992).

Preliminary results from our work in Pinelands streams show that banded sunfish (*Enneacanthus obesus*) from disturbed and pristine sites are infected with the trematode *Phyllodistomum*. However, it is not clear how infection is acquired in the pristine streams because an intermediate host necessary for the life cycle does not occur in these streams. We believe it may be related to dispersal behavior of fish hosts (i.e. they acquire the infection from less acidic waterways and migrate to the pristine streams). Banded sunfish are one of the restricted native fish species of the Pinelands and live almost exclusively in acidic blackwater habiats where the presence of many other species is limited by their intolerance to the acidic water and by dietary constraints (Graham & Hastings, 1984). In comparison to other related species, banded sunfish are favored in blackwaters because they are more acid tolerant and can glean on invertebrates that live on the stems and leaves of aquatic macrophytes (Graham, 1989). Besides morphological data, geographical distribution, and foraging habits of banded sunfish, there exists little direct evidence on other biological parameters of this fish species (e.g. little is known on the reproductive biology and dispersal patterns of this species, especially in those populations living in lotic habitats).

We propose to use parasitic helminths as biological tags to study the dispersal behavior of the banded sunfish. *Phyllodistomum* sp. (Trematoda) infecting native banded sunfish have been identified as potentially good biological tags from our ongoing research in some Pinelands streams. Studies such as this are important because they will allow us to gain a better understanding of the biology of native fish species before further habitat degradation occurs and we lose the opportunity to learn how this ecosystem normally functions and is structured.

Preliminary Data

In 1999 the NJWRRI provided us with funds to study the parasite fauna from fish in the Pinelands with the objective of identifying appropriate parasite species that can serve as bioindicators of disturbance. Analysis of the parasites found in banded sunfish (n=72) from 4 streams (the 2 most disturbed and 2 least disturbed (pristine) according to Zampella & Bunnell (1998)) show that the digenetic trematode, *Phyllodistomum*, occurs in all streams. In the disturbed streams *Phyllodistomum* occurs in 12.12% of the fish (n=33) but in 7.7% of the fish (n=39) in pristine streams. Adult *Phyllodistomum* spp. infect the urinary bladder of their fish host. Embryonated eggs are passed into the free-living environment where they hatch and infect fingernail clams (particularly some members of the Family Sphaeridae) where further development occurs before a second type of free-living infective stage is released and infects nearby naiads of damselflies or caddisfly larvae (see Hoffman, 1999). The damselflies and/or caddisfly larvae are then ingested by the fish definitive host and the life cycle is complete. However, fingernail clams do not occur in the pristine sites (NJDEP, 1996). Many molluscs are sensitive to acidity (Kinsman, 1984; Rooke and Mackie, 1984) and this may be due to the scarcity of shell building calcium in acid streams (McCormick, 1970). In light of this, the presence of *Phyllodistomum* in fish from these pristine streams is surprising. We hypothesize that the presence of *Phyllodistomum* in banded sunfish from acidic streams will increase as we sample from upstream areas towards the lower stretches where mixing of water from different, and often more disturbed, branches occurs (See Figure 1).

Acidity decreases from upstream to downstream along stretches of this landscape (R. Zampella, pers. comm.), making the habitat more hospitable to more invertebrate species including the molluscan first intermediate hosts necessary for the completion of the *Phyllodistomum* life cycle. The parasite tags will therefore give us a measure of the dispersal behaviors of banded sunfish across the Pinelands landscape. Banded sunfish may pick up the parasite infection in less acidic streams where association with molluscs occurs and later disperse upstream to more acidic branches.

Methods

We will collect 20 banded sunfish from each of 3 locations along 5 streams (see Figure 1). Two streams (Indian Mills Brook and Muskingum Brook) run into the Springers Brook, all of which are disturbed. These streams subsequently run into the Batsto River, which is less disturbed in terms of percent land cover, but has high pH values (Zampella and Bunnell, 1998, R. Zampella, pers. Comm.). Three streams (Skit Branch Creek, Mannis Duck Pond Creek, and Penn Swamp Creek) are low disturbance streams. Sampling locations will be mapped using a GPS unit and specimens will be collected using a seine every 2 months starting in March until November 2000. Abiotic parameters including pH and conductance will also be collected. In addition, invertebrate samples will be taken from each location taking special note of the presence or absence of all the intermediate hosts required in the life cycle of *Phyllodistomum*. Data on fish sex, total length and weight, and prevalence and intensity of infection for *Phyllodistomum* recovered will be analyzed using multivariate statistics.

Through this study, we hope to gain a better understanding of interactions between native species and their habitat in an ecosystem that still functions "normally" and whose structure has not been compromised entirely by anthropogenic stressors. In addition, the study will contribute to the characterization of existing diversity in New Jersey.

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